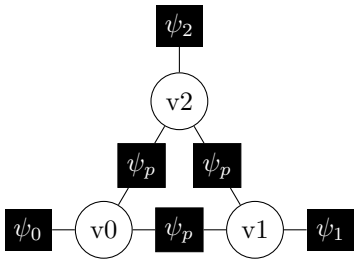
Exercise 3

Deadline: 12.05.2017, 2:15 pm
Regulations: You should hand in the exercises in groups of two or three persons. Please send a *compressed* (!) directory or file containing your solutions including all graphics, descriptions and source code to *thorsten.beier@iwr.uni-heidelberg.de*. The subject line of this email should start with [MLCV17][EX03] followed by the full names of all group members. Please cross-reference your code files in your writeup, such that it is clear which file has to be run for each exercise.

1 Linear Programs (LP) (20 points)

In this exercise we optimize a graphical model with a **Linear Program** We use a very simple graphical model with 3 variables x_0, x_1, x_2. Each variable can take one of 2 states: $x_i \in \{0, 1\}$. The structure of the graphical model is given below:



1.1 Implementation (15 Points)

Write code to optimize / minimize the graphical model above with **Linear Programming**.

- Set up the coefficients vector and the constraint matrix.
- use `scipy.optimize.linprog` to optimize the LP (Reference Documentation:scipy.optimize.linprog)

1.2 Attractive and Repulsive Potentials Part 1 (5 Points)

Use the potentials below and solve the linear program for $\beta = 1.0$ (attractive) and $\beta = -1.0$ (repulsive). Comment on the results.

x_0	$\psi_0(x_0)$
0	0.1
1	0.1

x_1	$\psi_1(x_1)$
0	0.1
1	0.9

x_2	$\psi_2(x_2)$
0	0.9
1	0.1

x_i	x_j	$\psi_{ij}(x_i, x_j)$
0	0	0
0	1	β
1	0	β
1	1	0

2 Bonus: Affinity Propagation as ILP (20 points)

Affinity propagation is a clustering algorithm which works by "passing messages" between data points. Affinity propagation tries to maximize the in cluster similarity. Unlike k-means, affinity propagation does not require a a fixed number of clusters.

Affinity propagation can be formulated as an ILP.

- Read the paper Clustering by passing messages between data points
- Formulate "Affinity Propagation" as ILP with all necessary constraints
- How many variables and constraints are necessary